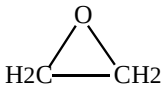
ETHYLENE OXIDE

Identified as a toxic air contaminant under California's air toxics program (AB 1807) in 1987.

CAS Registry Number: 75-21-8

Molecular Formula: C_2H_4O



Ethylene oxide is a colorless, flammable gas at ordinary room temperature and pressure condensing to a liquid below 12 ºC (Merck, 1989). It is highly soluble in water and many organic solvents. Liquid ethylene oxide is miscible with alcohol, benzene, acetone, carbon tetrachloride, and ether. The liquid is lighter than water and the vapor is heavier than air. Ethylene oxide is explosive with a sweet, ether-like odor (HSDB, 1995).

Physical Properties of Ethylene Oxide

Synonyms: 1,2-epoxyethane; oxirane; Amprolene; ETO; oxyfume; T-gas; dimethylene oxide

Molecular Weight:	44.06
Boiling Point:	10.7 ºC at 760 mm Hg
Melting Point:	-112.5 ºC
Vapor Pressure:	1094 mm Hg at 20 ºC
Vapor Density :	1.52
Density:	0.8711 at 20/20 ºC
Log Octanol/Water Partition Coefficient:	-0.30
Conversion Factor:	1 ppm = 1.8 mg/m^3

(HSDB, 1995; Merck, 1989; Sax, 1989; U.S. EPA, 1994a)

SOURCES AND EMISSIONS

A. Sources

Ethylene oxide is registered as an antimicrobial disinfectant and is active against a wide variety of bacteria, fungi, and viruses. Ethylene oxide is used for the sterilization of surgical instruments and equipment in hospitals and veterinary institutions, and for the sterilization of equipment in food handling and food processing plants (DPR, 1996).

The licensing and regulation of pesticides for sale and use in California are the responsibility of

the Department of Pesticide Regulation (DPR). Information presented in this fact sheet regarding the permitted pesticidal uses of ethylene oxide has been collected from pesticide labels registered for use in California and from DPR's pesticide databases. This information reflects pesticide use and permitted uses in California as of October 15, 1996. For further information regarding the pesticidal uses of this compound, please contact the Pesticide Registration Branch of DPR (DPR, 1996).

Ethylene oxide kills microorganisms that may be found on heat-, moisture-, and radiation-sensitive materials without damaging the materials being treated. Following sterilization, the ethylene oxide used to treat the materials can be released into the environment. Ethylene oxide is also used as a chemical feedstock in the production of detergents, ethylene glycol, and glycol ethers, although sterilization accounts for more than 90 percent of the ethylene oxide emissions in California (ARB, 1991c). Ethylene oxide has been detected but not quantified in automobile exhaust and environmental tobacco smoke (ARB, 1995e).

The primary stationary sources that have reported emissions of ethylene oxide in California are hospitals, medical instrument and supplies manufacturers, and manufacturers of miscellaneous food and kindred products (ARB, 1997b)..

B. Emissions

The total emissions of ethylene oxide from stationary sources in California is estimated to be at least 122,000 pounds per year based on data reported under the Air Toxics "Hot Spots" Program (AB 2588) (ARB, 1997b).

In 1991, the Air Resources Board (ARB) adopted a regulation which required all but the smallest ethylene oxide users to control emissions from sterilizers by 99.99 percent and emissions from aerators by 95 to 99 percent (depending on the amount of ethylene oxide used annually), through application of best available control technology (ARB, 1991c).

C. Natural Occurrence

No significant natural sources of ethylene oxide are known. It may be emitted into the atmosphere as a result of biological processes. Ethylene oxide may be a product of ethylene catabolism by the ethylene-oxidizing bacterium strain (ARB, 1987c).

AMBIENT CONCENTRATIONS

No ARB data exist for ambient measurements of ethylene oxide. However, emission data for dispersion modeling were obtained from the operators of industrial facilities and hospitals which use ethylene oxide. The modeling study estimated that a population-weighted annual mean ethylene oxide concentration of about 0.09 micrograms per cubic meter ($\mu g/m^3$) or 50 parts per

trillion in 1985 (ARB, 1987c).

The United States Environmental Protection Agency (U.S. EPA) has also reported concentrations of ethylene oxide from 2 study areas during 1989. The overall mean concentration of 1.8 $\mu g/m^3$ or 1 part per billion was obtained from these studies (U.S. EPA, 1993a).

INDOOR SOURCES AND CONCENTRATIONS

Off-gassing from spices fumigated with ethylene oxide represents the only identified source of indoor air exposure. This exposure is not likely to be significant for the following reasons. First, consumers used stock at home in relatively small quantities of spices. Second, the U.S. EPA restricts ethylene oxide residues in ground spices to 50 parts per million or less upon leaving the packing facility. Third, ethylene oxide volatilizes relatively rapidly from spices, so most of the residual ethylene oxide would be gone (ARB, 1987c).

ATMOSPHERIC PERSISTENCE

The dominant gas-phase chemical loss process for ethylene oxide in the troposphere is expected to be by reaction with the hydroxyl radical (OH). The calculated half life and lifetime due to gas-phase reaction with the OH radical are estimated to be about 4 months and 6 months, respectively (Atkinson, 1995). Based on the most recent studies, both the reaction with OH radicals and hydrolysis would reduce ambient concentrations of ethylene oxide only over a period of weeks. Rain and fog are not expected to be important removal mechanisms (ARB, 1987c).

AB 2588 RISK ASSESSMENT INFORMATION

The Office of Environmental Health Hazard Assessment reviews risk assessments submitted under the Air Toxics "Hot Spots" Program (AB 2588). Of the risk assessments reviewed as of April 1996, ethylene oxide represented the principal cancer risk driver in 12 of the approximately 550 risk assessments reporting a total cancer risk equal to or greater than 1 in 1 million and contributed to the total cancer risk in 24 of these risk assessments. Ethylene oxide also was the major contributor to the overall cancer risk in 2 of the approximately 130 risk assessments reporting a total cancer risk equal to or greater than 10 in 1 million, and contributed to the total cancer risk in 9 of these risk assessments (OEHHA, 1996a).

For non-cancer health effects, ethylene oxide contributed to the total hazard index in 6 of the approximately 89 risk assessments reporting a total chronic hazard index greater than 1, and contributed to the total hazard index in 3 of the approximately 107 risk assessments reporting a total acute hazard index greater than 1 (OEHHA, 1996b).

HEALTH EFFECTS

The most probable route of human exposure to ethylene oxide is by inhalation (U.S. EPA, 1994a; HSDB, 1995).

Non-Cancer: Ethylene oxide vapors are irritating to the skin, eyes, and respiratory tract. Effects include: nausea, vomiting, headache, dyspnea, cyanosis, pulmonary edema, drowsiness, incoordination and death (Proctor, et al, 1988). Long term exposures may result in cataracts in humans (U.S. EPA, 1994a). Chronic over exposures can cause peripheral neuropathy and central nervous system impairment (Olson, 1994).

A chronic non-cancer Reference Exposure Level (REL) of 6.0×10^2 $\mu g/m^3$ is listed for ethylene oxide in the California Air Pollution Control Officers Association Air Toxics "Hot Spots" Program, Revised 1992 Risk Assessment Guidelines. The toxicological endpoint considered for chronic toxicity is the reproductive system (CAPCOA, 1993). The U.S. EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for ethylene oxide (U.S. EPA, 1994a).

Human studies indicate that inhalation exposure to ethylene oxide may result in adverse reproductive effects such as an increased rate of miscarriages. Animal studies have shown adverse effects in male and female reproduction and fetal development (U.S. EPA, 1994a). The State of California has determined under Proposition 65 that ethylene oxide causes reproductive toxicity in females (CCR, 1996).

Cancer: Human occupational studies have shown that inhalation of ethylene oxide is associated with an increased incidence of Hodgkins disease, leukemia, and stomach and pancreatic cancer (U.S. EPA, 1994a).

The U.S. EPA has classified ethylene oxide in Group B1: Probable human carcinogen (U.S. EPA, 1994a).Inhalation of ethylene oxide has been shown to cause leukemia, lung, brain, and uterine tumors in rats (Proctor, et al., 1988). The International Agency for Research on Cancer has classified ethylene oxide in Group 1: Carcinogenic to humans (IARC, 1994b).

The State of California has determined under Proposition 65 that ethylene oxide is a carcinogen (CCR, 1996). The inhalation potency factor that has been used as a basis for regulatory action in California is 8.8×10^{-5} (microgram per cubic meter)$^{-1}$ (OEHHA, 1994). In other words, the potential excess cancer risk for a person exposed over a lifetime to 1 $\mu g/m^3$ of ethylene oxide is estimated to be no greater than 88 in 1 million. The oral potency factor that has been used as a basis for regulatory action in California is 0.31 (milligram per kilogram per day)$^{-1}$ (OEHHA, 1994).